

**DESIGN & ANALYSIS OF EXPERIMENTS
IE400, FALL 2024**

COURSE INFORMATION

Designated Class Times: MW 2:00-3:20 PM CT
Credit Hours: 3 hours (4 hour option for graduate students)
Course Websites: <https://canvas.illinois.edu> (primary course website)
<https://www.gradscope.com/> (submitting assignments, see “Assignment Policies”)
Instructor: Douglas M. King, Ph.D. (dmking@illinois.edu)
Office Hour*: Monday, 2:00-2:50PM CT (on Zoom)
* - Office hours may also available by appointment (please arrange by email, providing at least 24-hours of advance notice)

Textbook: "Design and Analysis of Experiments", Douglas C. Montgomery (10th Edition)
Prerequisite: IE 300 (required)
Course Type (ISE): Required (IE Curriculum)

Course Description: This course is intended to be an introduction to the principles of designing experiments and analyzing experimental data that these experiments produce.

Learning Outcomes: Following the completion of this course, students should be able to...
(¹⁻⁷: ABET Outcomes) ...understand and apply key principles of experimental design (e.g., randomization, blocking) ^{1,6}
...develop a systematic framework for thinking about and selecting experimental designs ^{1,6}
...discuss the mathematical model and assumptions associated with an experimental design ^{1,6}
...present statistical results to audiences of varying backgrounds ^{3,6}

COURSE STRUCTURE AND POLICIES

OVERVIEW: Synchronous vs. Asynchronous

While much of the content for this course will be delivered asynchronously, some course activities must be completed synchronously, and other activities are available (though not required) synchronously. Currently, the following synchronous activities are planned:

- **Required Synchronous Activities:** Exams
- **Optional Synchronous Activities:** Office Hours, Possibly Other Activities

Lecture Content: What to expect each week...

- **Weekly Lecture Videos (Asynchronous):** Lecture videos will be available asynchronously in the “Lecture Videos” module on Canvas. The list of lecture videos for each week is posted in the Course Calendar pdf; you can watch these videos at a time that is convenient for you during the week. All videos pertaining to a particular topic will be posted together, so you will typically have the option to work ahead. Additional videos (e.g., to provide additional examples or discuss other course content) will be posted as needed.
- **Office Hours (Synchronous):** Since the scheduled office hour takes place during designated class time, each week’s scheduled office hour can be treated as an informal discussion period (i.e., no specific material will be planned beforehand) where all students are welcome to attend and ask questions about the course content and other topics related to supply chain. If needed, this office hour or other designated class time may be replaced on some occasions by a more structured Q&A session with pre-planned topics and materials with the goals of discussing the course content in a “live” setting. The dates of any synchronous sessions will be announced in advance, and will be held via Zoom.

Course Announcements and Interaction Opportunities: You will have several ways to interact with the course staff and with your fellow students, and to ask course policy questions to course staff. Course announcements will also be made throughout the semester to keep you apprised of key milestones, deadlines, and requirements for the course.

- **Canvas Announcements:** The Announcements page on Canvas will be your primary source for critical course-related announcements (e.g., updates in course policies or deadlines). You are responsible for being aware of these announcements; checking at least once each business day is recommended to ensure prompt notification, and to avoid missing any announcements or deadlines.
- **Canvas Calendar:** In addition to the Course Calendar pdf, important dates will also be posted in the calendar section of Canvas.
- **Discussion Board:** A discussion board is available on Canvas where course staff will respond to course questions. Students are also encouraged to discuss their questions with one another by posting an existing thread or creating a new thread.
- **Office Hours:** For discussion of course content in a synchronous environment (e.g., outside of the discussion board). The office hour schedule is posted at the beginning of this syllabus; office hours may also be available by appointment.
- **Email:** For general questions outside of office hours, as well as all student-specific questions (e.g., grade-related).
- **NOTE – Student-Specific Questions:** During the course, you may have questions specifically related to your personal circumstances or grades. To maintain the confidentiality of this information, please ask these questions via email to course staff, or in an individual appointment with course staff. To preserve the confidentiality of your personal information, course staff will not respond to these questions in publicly-accessible environments (e.g., on the discussion board).

Attendance: While much of the course content can be accessed under a flexible asynchronous schedule, it is expected that you will keep pace with the course as it progresses. This includes watching lecture videos according to the assigned schedule in the course calendar, completing homework assignments by their deadlines, taking exams according to their (synchronous) schedule, and so forth. If you anticipate an extended and unavoidable period where you will be unable to access or participate in the course, or unavoidable absences during critical course meetings (e.g., exams), please

alert the instructor as soon as possible if you believe that course-related accommodations beyond those provided in this syllabus are necessary and justified. Such cases will be considered on a case-by-case basis and will require additional University documentation (typically including, but not limited to, an absence letter from the Office of the Dean of Students).

Access to Electronic Materials: Access to electronic recordings used in this course is offered only for students enrolled in the course via the posted platforms, and only for the duration of the course. Recording or storing recordings of any course materials, including lectures, discussions, or other activities is forbidden. Sharing recorded material or posting it online is also forbidden. Any violation of these policies will be forwarded to the Office of Student Conflict Resolution for disciplinary action.

GRADING AND POLICIES

Grades will be based on the following:	Exams (two)	50%	(30% and 20%, see “Exam Policies”)
	Project	25%	
	Homework assignments	20%	
	Quizzes	5%	

Exam Policies (Midterm and Final):

- **Schedule:** Exam dates will be announced on Canvas. The midterm will be scheduled to take place during designated class time (i.e., 2:00-3:20PM CT on MW), and the final exam will be scheduled according to University guidelines. **Exams will need to be taken synchronously according to the designated schedule.** Please plan ahead to be available during the exams.
- **Internet Reliability:** Exams are planned to be taken online, and will require an Internet connection. To the greatest extent possible, please make arrangements to have access to a reliable Internet connection during exams. If you lose your Internet connection during an exam, we will do our best to allow you to resume your exam, but your exam clock will continue to run while you are logged out, and we cannot guarantee that you will be able to resume your exam.
- **Absences and Accommodations:** To ensure that student performance is assessed uniformly, make-up exams are only offered in rare circumstances. Students who have an unavoidable, University-approved, and documented reason to be absent during the midterm exam will have their final exam score replace it when determining course grades. Make-up final examinations are only offered if required by University policy, or a student has made arrangements with their college to receive an “I” (Incomplete) grade in the course. Other missed examinations will receive a grade of zero. Please notify the instructor as early as possible if you believe you will need to take a make-up final exam; make-up exam arrangements will be made on a case-by-case basis. To accommodate extraordinary and unavoidable circumstances that may arise and negatively impact exam performance, students who take both exams will have their better exam score weighted more heavily when determining their course grade; the better exam score will count for 30% of their course grade and the lower exam score will count for 20% of their course grade.
- **Allowed materials:** The exams are open-book and open-notes. Calculators are allowed. Other than referencing pdf files posted to Canvas by the course staff and your own personal notes, you are not permitted to access other Internet resources (e.g., websites or other Internet sources). Contacting or otherwise consulting with other people during an exam is not permitted.
- **Regrades:** If you believe that an error has been made while grading your exam, please alert the instructor via email within one week after the exam scores are posted. This email must include rationale for why you believe additional credit is justified. Be as specific as possible; requests with insufficient rationale may be disregarded. No regrade requests will be accepted after the one-week deadline has passed.

Quiz Policies: Quizzes will be held to assess student engagement in the course and understanding of course topics.

- **Schedule:** Quiz dates may or may not be announced in advance. Once posted, any quiz will be available until at least 24 hours after start of the next designated class time. For example, a quiz posted on Tuesday would be available until at least 2:00PM CT on Thursday (i.e., 24 hours after the start of the designated class time on Wednesday).
- **Platform:** Quizzes will be held on Canvas, and will be posted in the “Quizzes” module when they are available.
- **Quiz duration:** Most quizzes will be timed, and the duration of each quiz will be shown before you begin the quiz; the duration of each timed quiz will typically be 5-20 minutes.
- **Absences: Make-up quizzes are not offered.** Any missed quiz will receive a grade of zero. To accommodate unavoidable absences that may occur during the semester, each student’s lowest quiz score will be dropped.
- **Allowed materials:** The exams are open-book and open-notes. Calculators are allowed. Other than referencing pdf files posted to Canvas by the course staff and your own personal notes, you are not permitted to access other Internet resources (e.g., websites or other Internet sources). Contacting or otherwise consulting with other people during an exam is not permitted.

Assignment Policies:

- **Schedule:** Roughly five homework assignments will be collected throughout the semester. Due dates will be posted on Canvas; you will have approximately one week to complete each assignment.
- **Platform/Submission:** Assignments will be submitted via Gradescope. Instructions for how to submit homework assignments will be provided. Please follow these instructions carefully! **Late submissions will not be accepted!** Each student’s lowest homework assignment score will be dropped.
- **Access to Gradescope:** Students will be added to the Gradescope roster after the tenth day of classes; an announcement will be made on Canvas once the roster has been added. If you add the course after that time, or find that you do not have access to the course’s Gradescope site after this announcement is posted, please contact the instructor as soon as possible.
- **Assignment Groups:** You will submit assignments in groups of three to four students. Groups will be created based on a Group Preference Form that each student will be asked to submit. More details will be provided.

- **Regrades:** After each assignment is returned, there will be a one-week period when regrade requests will be permitted. These requests must be made via Gradescope, and must include detailed rationale for why you believe additional credit is justified. This rationale should be as specific as possible, and refer to specific errors that were made in the grading (e.g., if you believe that some of your work was missed or misinterpreted by the grader, such that you did not receive credit for work that you submitted). Requests with insufficient rationale may be disregarded. No regrade requests will be accepted after the one-week deadline has passed.

Course Project Policies: Students will complete a course project, which will involve designing an experiment, gathering and analyzing experimental data, and presenting and interpreting your results. This project will be completed in the same Assignment Groups discussed above. As part of the project, each group will submit a project proposal before conducting the experiment. This proposal will include a description of the experiment, a brief summary of the how the experiment and analysis will be conducted, including any hypotheses you plan to explore. Your proposal must be reviewed and approved before you can begin collecting any data for your experiment. At the end of the semester deliverables will include a formal written report documenting your experiment and your results, and may also include as a short presentation of your experiment and key findings. More details will be provided.

Graduate Students (Four Credit Option): Graduate students enrolled for four credit hours will study additional topics and complete additional work to earn the additional hour of credit. The exact nature of this additional work has not yet been determined; the additional topics may be sourced from additional chapters of the textbook or from research papers, and the additional work may involve extra questions on exams, extra homework assignments, a project, or a combination thereof. The quality of this work will impact the course grade. More information will be provided around the end of the third week of the semester. Graduate students are responsible for enrolling in the proper credit level by the University deadline; changes will not be permitted after the deadline has passed.

Computation Policies (Assignments/Exams/Quizzes): For computational questions on exams and quizzes, please report your final numerical answer; provide at least four significant digits, to ensure that your work can be properly assessed. On homework assignments, please simplify any computations to a final numerical answer; show all your work to demonstrate your understanding of course content so partial credit can be assessed.

Statistical Software: There are many computational tools for statistical analysis of data. In this course, we will solve initial examples by applying basic tools (e.g., spreadsheets) to demonstrate the individual computational steps involved in carrying out statistical analysis. We will then solve some of these problems (and more advanced problems) using more advanced statistical software that can produce more comprehensive analysis for more complex analytical models. While statistical software can typically analyze the initial examples without reviewing basic steps, skipping to this step may prevent you from gaining intuition for the analytical process. Hence, you are encouraged to pay attention to both approaches when they are presented. Finally, students who are proficient in a particular statistical software package can use the package of their choice when completing statistical analysis; however, course staff are unlikely to be able to provide technical guidance for software that is not discussed in the course.

Academic Integrity: It is expected that your exams and quizzes will contain only your own work, and that your assignments and project will contain only the work of your group. Any student who misrepresents their work in an exam or quiz, or group who misrepresents their work on an assignment or project, will receive a grade of zero on that exam, quiz, assignment, or project; other sanctions may also be pursued, as allowed by University policy. Any homework assignment, quiz, exam, or project on which an academic integrity infraction has occurred cannot be dropped or replaced when computing a student's final course grade.

ADDITIONAL CAMPUS POLICIES

Disability-Related Accommodations: All reasonable accommodations required for students with disabilities will be offered, as ensured by Article 1, Part 1 of the Student Code. Documentation of accommodations from the Division of Disability Resources and Educational Services (DRES) must be provided before accommodations are offered. Please provide this documentation to the instructor by the end of the first week of class to ensure that accommodations can be offered in a timely manner. If documentation is provided after this time, accommodations will be provided as soon as is practical, but may be delayed by a week or more from the time of the request. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnose a previously undiagnosed disability; you may begin exploring resources by visiting the DRES website (<https://dres.illinois.edu/>) and selecting "Apply for Services" at the top of the page.

Religious Observances: Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at <https://odos.illinois.edu/community-of-care/resources/students/religious-observances/> to request appropriate accommodations. This should be done in the first two weeks of classes, or within one week of any course deadlines announced after the second week of class.

Sexual Misconduct Reporting Obligation: The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential

Other information about resources and reporting is available here: wecare.illinois.edu

Family Educational Rights and Privacy Act (FERPA): Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.

TENTATIVE LIST OF TOPICS

Introduction to Design and Analysis of Experiments

- Key principles
- Randomization, replication, blocking
- Guidelines for designing experiments

Review of Statistical Methods

- Sampling distributions (Z, T, Chi-squared, F)
- Confidence intervals (one- and two-sample)
- Hypothesis testing (one- and two-sample)

Analysis of Variance

- Statistical foundations
- One-factor ANOVA
- Two-factor ANOVA
- Linear regression
- Residual analysis
- Contrast analysis

Block-Focused Designs

- Randomized Complete Block Designs
- Latin Square Design
- Graeco-Latin Square Design

Factorial Experiments

- Full factorial experiments
- 2^k factorial experiments
- Fractional factorial experiments
- Aliasing, blocking, and confounding

Additional topics (time permitting)

- Response surface methods
- Gathering data
- Random effects models
- Variable transformations

NOTE: The policies contained in this syllabus are subject to change. Any such changes will be posted on Canvas.